

**Core Object Model for Network Management Configuration Applications in
Telecommunication Systems**

CROSS REFERENCE TO RELATED APPLICATION

5 This application claims priority of Provisional Application Serial No. 60/264934 which was filed January 30, 2001.

FIELD OF THE INVENTION

The present invention relates generally to the field of Network Management in
10 Telecommunication Systems, and more specifically to an object model for such a Network Management system.

BACKGROUND OF THE INVENTION

The Network Management Configuration Domain for Telecommunication
15 Systems suffers from not having a generic object model that addresses the issues of modeling telecommunications physical and logical components and devices. Different Network Management vendors have proprietary modeling schemas that reflect object models that are similar to their device structure. These proprietary models, however, are difficult to re-use and extend to build a generic Network Management Configuration
20 object model. The problem of not having a Core Network Management object model that is generic and re-usable translates into having to re-architect the object model multiple times which consumes valuable design and implementation time, energy and cost.

Existing Network Management System (NMS) configuration object models have various shortcomings including not having isolation of business logic in just the specific

leaf objects, but rather being proliferated throughout the object model; not distinguishing properly between Network Management Action objects that are required to manipulate specific core objects; and lacking an interaction mechanism to make the objects completely unaware of session and event information. In addition, prior art NMS configuration object models lack abstraction so as to be generically applicable to any network management object model and are not easily re-usable.

Accordingly, a need exists for a generic and re-usable core network management object and action model will solve the above problems.

10 **SUMMARY OF THE INVENTION:**

The Core Network Management Object Model of the present invention generically models the physical and logical objects in a configuration management system. The present invention also models the generic action objects required to manipulate the network objects. Unique object level information is isolated at the leaf level of the object model and is not proliferated to other generic parts of the model. The action objects all model different actions that need to be performed in a configuration application architecture and insulates the network objects from having any knowledge of session and event information. Leaf objects and actions are specialized to perform any configuration related actions. In the Core Network Management Object Model an Object Factory creates the unique object and an Action Factory creates the unique action. The action shall then be performed on the unique object to get, set and modify device information through SNMP and also to store the information in the database. This makes the object model for both the network objects and actions re-usable, scalable, and

extendable. Use of the present invention drastically reduces development time and effort so that the same objects can be re-used in different applications and solutions.

5 **BRIEF DESCRIPTION OF THE DRAWINGS**

A more complete understanding of the present invention may be obtained from consideration of the following detailed description of the invention in conjunction with the drawing, with like elements referenced with like references, in which:

FIG. 1 is an exemplary embodiment of a core network management object model

10 with circuit objects as leaf entities;

FIG. 2 is an exemplary embodiment of a core network management object model with logical ports as leaf entities;

FIG. 3 is an exemplary data flow diagram for a specific request in the object model.

15

DETAILED DESCRIPTION OF THE INVENTION:

The present invention is a Core Network Management Object Model that generically models the physical and logical objects of a configuration management system. The invention also models generic action objects required to manipulate the

20 network objects. Unique object level information is isolated at the leaf level of the object model and is not proliferated to other generic parts of the model. Action objects model different actions that need to be performed in a configuration application architecture and

insulate the network objects from having any knowledge of session and event information. Leaf objects and actions are specialized to perform any configuration related actions.

In the Core Network Management Object Model of the present invention, an

- 5 Object Factory creates the unique object and the Action Factory creates the unique action. The action shall then be performed on the unique object to get, set and modify device information through SNMP and also to store the information in the database. This makes the object model for both the network objects and actions re-usable, scalable, and extendable. This drastically reduces development time and effort so that the same objects
- 10 can be re-used in different applications and solutions.

The Core Network Management Object Model of the present invention can be directly used in implementing most any Network Management application so that the usage of the model is immediate. The reusability feature of the model greatly enhances the cost savings in implementing this object structure. The core object model can translate into significant savings by providing a software object model that simplifies architecture, design and development of any NMS application.

- 15 Referring generally to Fig. 1, the Core Network Management Object Model architecture of the present invention includes a series of fundamental objects that represent the root of an inheritance tree for Network Management Configuration Applications. The object model can be extended to build a network management configuration object hierarchy. This helps specific developers to build applications by using base classes and interfaces provided in the model instead of defining their own
- 20

object architecture. The “BFW” pre-fix is used in the object model to denote Base Framework objects. The “Ifc” post-fix is used to denote interface objects. The “Impl” post-fix is used to denote implementation objects.

The object models 100, 200 of Figs. 1 and 2 are represented and described using

5 nomenclature of the Java programming language. As would be understood by those skilled in the art of computer programming, the object models of the present invention are equally applicable to other similar programming languages. As shown, the object models of the present invention include abstract classes, standard classes and interface objects.

As would also be understood, a Class is a way to group data and methods together into
10 one coherent package and an Object is a unique instance of a class. Relations and inheritances (the idea of using one class to create another) between classes and objects are illustrated with unbroken lines and arrows, respectively. Implementations between classes and interface objects, where an interface defines methods that a class implements, are illustrated using broken arrows.

15 Referring to Fig. 1, a description of the main interfaces and objects in the Core Network Management Object Model 100 follows. Beginning at the top section of the model 100 in the core classes box 102, a BFWBaseIfc interface 104 provides capabilities needed by Core Network Management Objects. These capabilities allow an object to be initialized, uninitialized etc. The BFWBaseImplAbs abstract object 106 implements the
20 BFWBaseIfc interface 104. A BFWContainerIfc interface 108 is inherited from the BFWBaseIfc interface 104. The BFWContainerIfc interface 108 is used in manipulation of contained objects. A BFWContainerImplAbs abstract object 110 shall implement the BFWContainerIfc interface 108.

Proceeding generally downward in the model, a BFWObjectContainerIfc interface 112 defines generic object container methods that are utilized by a BFWNetworkEntityIfc interface 114. The BFWObjectContainerIfc interface 112 supports creation, deletion, access, and naming of entities. The BFWObjectContainerImplAbs object 116 implements

5 the BFWObjectContainerIfc interface 112. The BFWNetworkEntityIfc interface 114 allows dynamic extensions by implementing the BFWAttributeContainerIfc interface 118 and the BFWObjectContainerIfc interface 112. A BFWNetworkEntityImpl object 120 implements the BFWNetworkEntityIfc interface 114. The BFWAttributeContainerIfc interface 118 defines generic attribute container methods that are utilized by the

10 BFWNetworkEntityIfc interface 114.

A BFWActionContainerIfc interface 122 is the base interface for all action objects that are transient in nature and operate on the network objects to perform the task. A BFWActionContainerImplAbs object 124 implements the BFWActionContainerIfc interface 122. Below the BFWActionContainerIfc 122, the BFWActionIfc interface 126 object 126 defines all actions required for network objects in the object model. The BFWActionImplAbs object 128 implements the BFWActionIfc interface 126.

As can be seen, the present invention model also includes a sample grouping of action classes 130. A BFWGetOperationalInfoActionIfc interface object 132 is responsible for getting operational information on network objects. The

20 BFWGetOperationalInfoActionImpl object 134 shall implement the get operational information interface. A BFWGetPeriodicStatisticsActionIfc interface object 136 is responsible for getting periodic statistics information on network objects. The BFWGetPeriodicStatisticsActionImpl object 138 implements the get periodic statistics

information interface. A BFWGetStatisticsActionIfc interface object 140 performs single get operations on network objects. The BFWGetStatisticsActionImpl object 142 implements the get statistics information interface.

A BFWStopStatisticsActionIfc interface object 144 performs stop operations on a network object. The BFWStopStatisticsActionImpl object 146 implements the stop statistics interface. A BFWAddActionIfc interface object 148 performs the add action on a network object. The BFWAddActionImpl object 150 implements the add action interface. A BFWDeleteActionIfc interface object 152 performs a delete action on a network object. The BFWDeleteActionImpl object 154 implements the delete action interface. A BFWGetActionIfc interface object 156 performs the get operation on non-statistics attributes on a network object. The BFWGetActionImpl object 158 implements the non-statistics get action interface. A BFWListObjectByParentActionIfc interface object 160 performs the list by parent action on a network object. The BFWListObjectByParentImpl object 162 implements the list by parent action interface. A BFWListObjectByTypeActionIfc interface object 164 performs list by object type action on a network object. The BFWListObjectByTypeActionImpl object 166 implements the list by object action interface.

As can be seen, the BFWActionIfc interface object 126 inherits each of the BFW “Action” interfaces below it. In a similar fashion, the BFWActionImplAbs inherits all of the BFW “Action” implementation objects below. As shown, each of the BFW “Action” interface objects and each of the BFW “Action” implementation objects have a relation to all of the objects which fall underneath a respective object.

The Network Management Object Model of the present invention also includes a sample grouping of Circuit Classes 170. A GenericEntityIfc interface object 172 is the interface object for all generic network entities and is inherited by the BFWNetworkEntityIfc interface object 114. The GenericEntityImplAbs object 174 implements the GenericEntityIfc interface 172. As shown, the following interface objects: CircuitGenericEntityIfc 176, CircuitAxAtmIfc 178, CircuitAxCeIfc 180, CircuitAxFrameIfc 182, CircuitCoreAtmIfc 184, CircuitCoreCeIfc 186, CircuitCoreFrameIfc 188 shall represent all interface objects for different types of sample Circuit objects. CircuitGenericEntityImpl 190, CircuitAxAtmImpl 192, CircuitAxCeImpl 194, CircuitAxFrameImpl 195, CircuitCoreAtmImpl 196, CircuitCoreCeImpl 197, CircuitCoreFrameImpl classes 198 shall represent implementations of the respective Circuit interface objects. The CircuitGenericEntityIfc interface object 176 inherits each of the “Circuit” interfaces below it. In a similar fashion, the CircuitGenericEntityImplAbs 190 inherits all of the “Circuit” implementation objects below. As shown, each of the Circuit interface objects and each of the Circuit implementation objects have a relation to all of the objects which fall underneath a respective object.

Referring to Fig. 2, an exemplary embodiment of the core network management object model 200 of the present invention is shown with logical port (LPorts) connection classes 270 as leaf entities. As shown, the core classes and sample action classes are identical to the embodiment 100 of Fig.1 (circuit objects). As with the circuit model, a GenericEntityIfc interface object 272 is the interface object for all generic network

entities and is inherited by the BFWNetworkEntityIfc interface object 214. The GenericEntityImplAbs object 274 implements the generic network interface. The following interface objects: LportGenericEntityIfc 276, LportGeneralIfc 278, LportEthernetIfc 280, LPortILMIIIfc 282, LportNodeToNodeIfc 284, LPortPNNIIIfc 286, 5 LportTrunkIfc 288, represent all interfaces objects for the different types of Logical Port objects. LportGenericEntityImpl 290, LportGeneralImpl 292, LportEthernetImpl 294, LPortILMIIImpl 295, LportNodeToNodeImpl 296, LPortPNNIIImpl 297, LportTrunkImpl 298 classes represent implementations of the respective Logical Port interface objects.

10 Referring to Fig. 3, a Data Flow Diagram 300 of the Object Model of the present invention is shown. The overall interaction mechanism between the client 302 and the server 304 is that the client requests information from the server 304 and the server asynchronously creates unique objects and unique actions that will work on the object. The action object then manipulates the network object by getting information from the 15 database and the device itself through SNMP, for example, to build the response for the client. After the construction of the response is complete and the information from the database and the device has been retrieved, the response is pushed back to the client. The exemplary data flow diagram depicts a client requesting get information on a specific object on the server.

20 As a first step of Client and Server interaction for a get(...) request, a Client provides a request for configuration information in the form of a get request on a specific object by invoking a ConfigurationClient.get(object, callback) request 306. At a next step, the request is serviced by the server 304 at the configuration request service which

generates a request createObject(...) 308 to the NetworkObjectFactory 310 to create the unique object e.g. configurationObject of type CircuitAxAtmImpl. At step 312, this unique object called configurationObject is then returned to the Configuration Request

Service 304. The Configuration Service 304 then creates a unique action at step 314 by

5 calling the createAction static method on the ActionObjectFactory 316 to create a unique

action getAction of type BFW GetActionImpl. The unique action called getAction is

then returned to the Configuration Request Service at step 318. The getDBInfo(...)

method is then called to get Database information on the object at step 320. At step 322,

the database information is returned to the service. The action object is then used to

10 retrieve the SNMP information of the device by calling the SNMP API 324 at step 326.

The SNMP API 324 then requests the get information on the specific object from the

device 328 at step 330. The SNMP information is returned to the SNMP API 324 at step

332. At step 334, the SNMP information is forwarded to the Configuration Service 304.

As a last step 336, the get request information of the configuration object is then returned

15 to the Client 302 requesting this information.

In Appendix I which follows, a detailed description of the interfaces and classes for use in the present invention follows. Appendix II includes exemplary Code samples of base classes to build corresponding network objects.

The foregoing description merely illustrates the principles of the invention. It will

20 thus be appreciated that those skilled in the art will be able to devise various

arrangements, which, although not explicitly described or shown herein, embody the

principles of the invention, and are included within its spirit and scope. Furthermore, all

examples and conditional language recited are principally intended expressly to be only

for instructive purposes to aid the reader in understanding the principles of the invention and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions.

Moreover, all statements herein reciting principles, aspects, and embodiments of the
5 invention, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. Additionally, it is intended that such equivalents include both currently known equivalents as well as equivalents developed in the future, i.e., any elements developed that perform the same function, regardless of structure.

In the claims hereof any element expressed as a means for performing a specified
10 function is intended to encompass any way of performing that function including, for example, a) a combination of circuit elements which performs that function or b) software in any form, including, therefore, firmware, microcode or the like, combined with appropriate circuitry for executing that software to perform the function. The invention as defined by such claims resides in the fact that the functionalities provided by the
15 various recited means are combined and brought together in the manner which the claims call for. Applicant thus regards any means which can provide those functionalities as equivalent as those shown herein. Many other modifications and applications of the principles of the invention will be apparent to those skilled in the art and are contemplated by the teachings herein. Accordingly, the scope of the invention is limited
20 only by the claims appended hereto.

Appendix I**Description of the interfaces and classes:**

5

1. BFWBaseIfc**Interface BFWBaseIfc**

Abstract interface that shall be supported by all objects to enable objects to be initialized

10 and uninitialized.

Subinterfaces:

BFWContainerIfc

15 Implementing Class:

BFWBaseImplAbs

| Method Summary | |
|----------------|--|
| void | <u>initialize()</u> Initialize the state of the object |
| void | <u>uninitialize()</u> Uninitialize and invalidate any handles to the object |

2. BFWBaseImplAbs

20

Class BFWBaseImplAbs

public abstract class BFWBaseImpl implements BFWBaseIfc

25 Abstract class supported by all objects to enable objects to be initialized and uninitialized.

| Method Summary | |
|----------------|---|
| void | <u>initialize()</u> Initialize the state of the object |
| String | <u>initialize()</u> Initialize the state of the object |
| void | <u>uninitialize()</u> Uninitialize and invalidate any handles to the |

| | |
|--|--------|
| | object |
|--|--------|

3. BFWContainerIfc

5 **public interface BFWContainerIfc extends BFWBaseIfc**

Abstract interface in order to be able to contain entities.

All Subinterfaces:

BFWActionContainerIfc, BFWObjectContainerIfc

10 **All Implementing Classes:**

BFWContainerImplAbs

| Method Summary | |
|-----------------------|---|
| int | getStatus() Returns a status for the object |

15

4. BFWContainerImplAbs

BFWBaseImplAbs

20 |

+ BFWContainerImplAbs

public abstract class BFWContainerImplAbs extends BFWBaseImplAbs

implements BFWContainerIfc

25 Abstract class that other classes shall implement in order to be able to contain entities.

Direct Subclasses:

BFWActionContainerImplAbs, BFWObjectContainerImplAbs

30

| Method Summary | |
|-----------------------|---|
| abstract int | getStatus() Returns a status for the object |

5. BFWObjectContainerIfc

35

public abstract interface BFWObjectContainerIfc extends BFWContainerIfc

Subinterfaces:

BFWNetworkEntityIfc

5

Implementing Class:

BFWObjectContainerImplAbs

| Method Summary | |
|-----------------------|---|
| void | decrementObjectInstanceCount() |
| java.lang.String | getHandle() Return a handle that refers to this entity object. |
| java.lang.String | getIntervalHandle() Return a handle that refers to an interval object. |
| java.lang.Class | getObjectImplClass() |
| int | getObjectInstanceCount() |
| void | incrementObjectInstanceCount() |
| void | setObjectImplClass(java.lang.Class objectClass) |

10 **6. BFWObjectContainerImplAbs**

BFWBaseImplAbs

|

+--BFWContainerImplAbs

|

+--BFWObjectContainerImplAbs

15

public abstract class BFWObjectContainerImplAbs extends BFWContainerImplAbs implements BFWObjectContainerIfc

Base class for all network objects.

20

Direct Subclasses:

BFWNetworkEntityImpl

| Method Summary | |
|-----------------------|---|
| protected void | destroy() Delete any objects that are contained by this object |
| String | getHandle() Return a handle that refers to this entity object |
| String | getIntervalHandle() |

| | | |
|--|------|--|
| | | Return a handle that refers to this entity object |
| | void | initialize() Initialize the state of the object |

7. BFWNetworkEntityIfc

5

**public abstract interface BFWNetworkEntityIfc extends BFWObjectContainerIfc,
BFWAttributeContainerIfc**

A BFWNetworkEntity shall allow attribute extensions by implementing the
10 BFWAttributeContainer Interface.

Implementing Classes:

BFWNetworkEntityImpl

| Method Summary | | |
|----------------|-----------------------|--|
| | void | addAttributeBy(java.lang.Integer attributeKey, java.lang.Object attributeToAdd) |
| | void | addAttributeBy(java.lang.String attributeKey, BFWObjectContainerIfc attributeToAdd) |
| | void | addAttributeBy(java.lang.String attributeKey, java.lang.Object attributeToAdd) |
| | boolean | containsAttributeKey(java.lang.Integer attributeKey) |
| | boolean | containsAttributeKey(java.lang.String attributeKey) |
| | void | decrementObjectInstanceCount() |
| | java.lang.Object | getAttributeBy(java.lang.Integer attributeKey) |
| | java.lang.Object | getAttributeBy(java.lang.String attributeKey) |
| | java.util.Enumeration | getAttributeEntries() |
| | BFWHashtable | getAttributeList() |
| | int | getObjectInstanceCount() |
| | void | incrementObjectInstanceCount() |
| | void | removeAttributeBy(java.lang.Integer attributeKey) |
| | void | removeAttributeBy(java.lang.String attributeKey) |
| | void | replaceAttributeBy(java.lang.Integer attributeKey, |

| | | |
|--|------|---|
| | | java.lang.Object attributeToReplaceBy) |
| | void | replaceAttributeBy(java.lang.String attributeKey, java.lang.Object attributeToReplaceBy) |
| | | |

8. BFWAttributeContainerIfc

public abstract interface BFWAttributeContainerIfc

5

| Method Summary | |
|-----------------------|---|
| | void addAttributeBy(java.lang.Integer attributeKey, java.lang.Object attributeToAdd) Add attributes by attributeKey |
| | void addAttributeBy(java.lang.String attributeKey, BFWObjectContainerIfc attributeToAdd) Add attributes by attributeKey |
| | void addAttributeBy(java.lang.String attributeKey, java.lang.Object attributeToAdd) Add attributes by attributeKey |
| | boolean containsAttributeKey(java.lang.Integer attributeKey) Check attribute by attributeKey |
| | boolean containsAttributeKey(java.lang.String attributeKey) Check attribute by attributeKey |
| | java.util.Map copyAttributeMap() Copy Attribute Map |
| java.lang.Object | getAttributeBy(java.lang.Integer attributeKey) Get attribute by attributeKey |
| java.lang.Object | getAttributeBy(java.lang.String attributeKey) Get attribute by attributeKey |
| | void removeAttributeBy(java.lang.Integer attributeKey) Remove attributes by attributeKey |
| | void removeAttributeBy(java.lang.String attributeKey) Remove attributes by attributeKey |
| | void replaceAttributeBy(java.lang.Integer attributeKey, java.lang.Object attributeToReplaceBy) |

| | |
|------|---|
| | Replace attribute by attributeKey |
| void | replaceAttributeBy(java.lang.String attributeKey, java.lang.Object attributeToReplaceBy) Replace attribute by attributeKey |

9. BFWNetworkEntityImpl

5 **public class BFWNetworkEntityImpl extends BFWObjectContainerImpl
implements BFWNetworkEntityIfc**

Shall implement the methods defined in the BFWNetworkEntityIfc interface.

10 **BFWBaseImplAbs**
 |
 +--BFWContainerImplAbs
 |
 +--BFWObjectContainerImplAbs
 |
 +--BFWNetworkEntityImpl
 15

| Method Summary | |
|------------------|---|
| void | addAttributeBy(java.lang.Integer attributeKey, java.lang.Object attributeToAdd) Add attributes by attributeKey |
| void | addAttributeBy(java.lang.String attributeKey, BFWObjectContainerIfc attributeToAdd) Add attributes by attributeKey |
| void | addAttributeBy(java.lang.String attributeKey, java.lang.Object attributeToAdd) Add attributes by attributeKey |
| boolean | containsAttributeKey(java.lang.Integer attributeKey) Check attribute by attributeKey |
| boolean | containsAttributeKey(java.lang.String attributeKey) Check attribute by attributeKey |
| java.util.Map | copyAttributeMap() Copy Attribute Map |
| java.lang.Object | getAttributeBy(java.lang.Integer attributeKey) |

| | | |
|------------------|--|--|
| | | Get attribute by attributeKey |
| java.lang.Object | | getAttributeBy(java.lang.String attributeKey) Get attribute by attributeKey |
| void | | removeAttributeBy(java.lang.Integer attributeKey) Remove attributes by attributeKey |
| void | | removeAttributeBy(java.lang.String attributeKey) Remove attributes by attributeKey |
| void | | replaceAttributeBy(java.lang.Integer attributeKey, java.lang.Object attributeToReplaceBy) Replace attribute by attributeKey |
| void | | replaceAttributeBy(java.lang.String attributeKey, java.lang.Object attributeToReplaceBy) Replace attribute by attributeKey |
| void | | setObjectImplClass(java.lang.Class objectClass) |

10. BFWActionContainerIfc

5 public interface BFWActionContainerIfc extends BFWContainerIfc

This is the base interface for objects that are actions and usually not stored in the database.

10

| Method Summary | |
|------------------------|--|
| BFWObjectContainerIfc | getOwningEntityRef() Get owning entity reference |
| java.lang.StringBuffer | getTraceData(java.lang.String s) Get Trace Data |
| void | setOwningEntityRef(BFWObjectContainerIfc entity) Set the owning entity reference |
| void | setEqual(BFWActionContainerIfc transientEntity) Sets the state of the Transient equal to the state of the specified source transient. |

11. BFWActionContainerImplAbs

**public abstract class BFWActionContainerImplAbs extends BFWContainerImpl
implements BFWActionContainerIfc**

5

BFWBaseImplAbs

10

Direct Subclasses:

BFWActionImplAbs

15

| Method Summary | |
|------------------------|--|
| boolean | equals(java.lang.Object transientToCompare) Compare two transient objects for equal state values |
| BFWObjectContainerIfc | getOwningEntityRef() Get owning entity reference |
| int | getPersistenceStatus() Get Persistence status |
| java.lang.StringBuffer | getTraceData(java.lang.String newLinePrefix) Get trace data |
| boolean | isStateless() Is the object stateless |
| void | setEqual(BFWActionContainerIfc dependent) Set the state of the Transient entity equal to the state of the specified source Transient entity |
| void | setOwningEntityRef(BFWObjectContainerIfc ref) Set owning entity reference |
| int | hashCode() Returns the hash code |

20

12. BFWActionIfc

public interface BFWActionIfc extends BFWActionContainerIfc

Interface class BFWActionIfc defines all actions required for objects

5 **Implementing Class:**

BFWActionImplAbs

| Method Summary | |
|-----------------------|---|
| boolean | canDo() Can the action be done. |
| void | doAll() Does all the operations for the action |
| void | doAction() Defines a transaction scope around the doAll() method |
| void | initialize() Initialize the action |
| void | initialize(BFWHandleAbs handle, boolean flag, java.lang.String s, int i) Initialize the action |
| void | setReturnAction(boolean flag) Set the return action |
| void | setState(int i) Set the state of the action |
| void | setTarget(BFWNetworkEntityImpl entity) Sets the target of the action. |

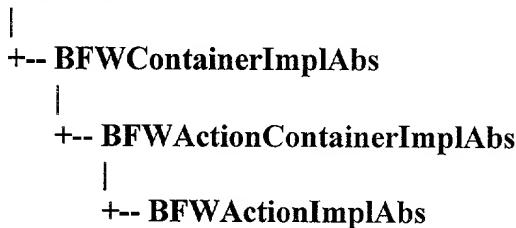
10 **13. BFWActionImplAbs**

**public abstract class BFWActionImplAbs extends BFWActionContainerImplAbs
implements BFWActionIfc**

BFWActions encapsulate tasks and other actions that control or modify network objects.

15

BFWBaseImplAbs



20

| Method Summary | |
|-----------------------|---|
| protected void | destroy() Destroys the action object |
| void | doBegin() Start the action |
| void | doTransaction() Defines a transaction scope around the doAll() method |
| boolean | equals(BFWActionContainerIfc object) Determines if this object's state is equal to the specified object argument |
| boolean | getReturnAction() Is the return action supported |
| void | handleReset() Handle the reset of the action. |
| int | hashCode() Return hashCode of object |
| void | initialize() Initialize the action |
| void | initialize(BFWHandleAbs newHandle, boolean returnAction, java.lang.String actionLabel, int undoType) Initialize the action |
| void | redo() Redo the action |
| void | reset() Reset the action |
| void | setEqual(BFWActionContainerIfc object) Sets the state of this object to state of another object of the same type |
| void | setReturnAction(boolean returnAction) Set the return action |
| abstract void | setTarget(BFWNetworkEntityImpl entity) Sets the target of the action. |

Appendix II

Code Samples of Base classes to build Network Objects

5

GenericEntityIfc

10

```
public interface GenericEntityIfc
    extends BFWNetworkEntityIfc
{
    /*-----
    ** Initialize the object and its attributes
    ** @param BFWServerRequest request
    ** @return void
    ** @exception BFWExceptionAbs
    ** @exception NXException Exception sent back to the Client      */
    /*-----*/
    public abstract void initialize(BFWServerRequest request)
        throws BFWExceptionAbs, NXException;

    public abstract void initialize(NXObject obj)
        throws BFWExceptionAbs, NXException;

    public abstract void initialize()
        throws BFWExceptionAbs, NXException,
    25
    public abstract long getInterval();

    public abstract Date getStartTime();

    30    public abstract Date getStopTime();

    public abstract void setHandle(String handle);

    public abstract String getHandle();

    35    public abstract void setIntervalHandle(String newHandle);

    public abstract String getIntervalHandle();

    40    public abstract Vector getClientCache();

    public abstract void updateClientCache(NXObject obj);

    45    public abstract void updateClientCache(NXObjectList objList);
}
```

45

GenericEntityImplAbs

50

```
public abstract class GenericEntityImplAbs extends BFWNetworkEntityImpl
    implements GenericEntityIfc
{
    /*-----
    ** GenericEntityImplAbs null Contructor
    **-----*/
    55    public GenericEntityImplAbs()
    {
    }

    /*-----*/
    /* Initialize the object
    ** This is an abstract method that must be implemented by
    ** concrete subclasses of this class
    ** @param BFWServerRequest request
    60
```

```

** @return void
** @exception BFWExceptionAbs
** @exception NXException */
5 public abstract void initialize(BFWServerRequest request)
throws BFWExceptionAbs, NXException;

public abstract void initialize(NXObject obj)
throws BFWExceptionAbs, NXException;
10 public abstract void initialize()
throws BFWExceptionAbs, NXException;

public abstract long getInterval();
15 public abstract Date getStartTime();

public abstract Date getStopTime();

20 public abstract void setHandle(String handle);

public abstract String getHandle();

public abstract void setIntervalHandle(String newHandle);
25 public abstract String getIntervalHandle();

public abstract Vector getClientCache();

30 public abstract void updateClientCache(NXObject obj);

public abstract void updateClientCache(NXObjectList objList);

}
35 CircuitAxAtmIfc

public interface CircuitAxAtmIfc
extends CircuitGenericEntityIfc
40 {
public abstract String getName();

public abstract int getIfIndex(int endpoint);

45 public abstract int getVpi(int endpoint);

public abstract int getVci(int endpoint);

public abstract int getDlcI(int endpoint);

50 public abstract String getIPAddress(int endpoint);

public abstract int getSlot(int endpoint);

public abstract int getPPort(int endpoint);

55 public abstract int getChannel(int endpoint);

public abstract int getLPortType(int endpoint);

60 public abstract int getEndpointType(int endpoint);

public abstract int getCardType(int endpoint);

65 public abstract int getSwitchType(int endpoint);

public abstract int getSwitchRevisionNumber(int endpoint);

```

CircuitAxAtmIfc

```

    public abstract Hashtable getAttributesForEndpoint(int endpoint);

    public abstract MOSIntervalCache getIntervalCache();
5   }

CircuitAxAtmImpl

10  public class CircuitAxAtmImpl extends CircuitGenericEntityImplAbs
     implements CircuitGenericEntityIfc
    {
        public CircuitAxAtmImpl()
        {
        }

15  public void initialize(BFWServerRequest newRequest)
     throws BFWEExceptionAbs, NXException
    {
        // Set the Circuit attribute cache size
20    super.initialize(DEF_CACHE_SIZE);
        this.request = request;
        objectID = request.getObject().getObjectId();
        argList = request.getObject().getAttrList();
        handle = request.getObject().getObjectId().getComponent("NAME").toString();
25    // Set the Circuit Interval Cache size which will be populated
        // by data retrieved from the data collector.
        intervalCache = new MOSIntervalCache(DEF_INTERVAL_CACHE_SIZE);

30    switch(request.getType())
    {
        case NXCommands.GET_STATS_CMD:
        case NXCommands.GET_DEMAND_STATS_CMD:
            case NXCommands.GET_PERIODIC_STATS_CMD:
            case NXCommands.START_MONITOR_CMD:
35            // All attributes of Circuit Type and Card Type
            // need to be initialized
            setFilterAttributes();
            setObjectType();
            break;
40        case NXCommands.GET_CMD:
            case NXCommands.GET_OPER_INFO_CMD:
            setFilterAttributes();
            setSpecificAttrs();
            break;
45        case NXCommands.STOP_STATS_CMD:
            case NXCommands.STOP_MONITOR_CMD:
            setFilterAttributes();
            break;
        default:
50            break;
    }
}

55  /*-----*/
/** Initialize the Circuit object with the NXObject
 *  This method is used on the client side.
 *  @param NXObject obj
 *  @return void
 */
60  public void initialize(NXObject obj)
     throws BFWEExceptionAbs, NXException
    {
        // Set the LPort attribute cache size
        super.initialize(DEF_CACHE_SIZE);
        // List of objects that are returned from the server
65        clientObjectList = new Vector();
        object = obj;
    }

```

```

argList = obj.getAttributeList();
handle = obj.getObjectId().getComponent("NAME").toString();
setFilterAttributes();
setObjectType();
5    }

/*
** Initialize the Circuit object with the attribute list
** This method is used to initialize the object from the
** cache manager
** @return void
*/
10   public void initialize()
     throws BFWExceptionAbs, NXException
15   {
     // Set the Circuit attribute cache size
     super.initialize(DEF_CACHE_SIZE);
   }

20   public Enumeration getAllAttributes()
   {
     return getAttributeEntries();
   }

25   public void setFilterAttributes()
   {
     NXArg arg = null;
     int i = 0;

30     if (argList == null)
       return;

35     for (int x = 0; x<argList.length(); x++)
     {
       arg = argList.getArgAt(x);
       i = arg.getId();

       switch(i)
       {
40         case NXCircuitAttributes.NAME:
           setName(i);
           break;

45         case MOSCircuitAttributes.END1_IFINDEX:
           setIfIndex(ENDPOINT1, i);
           break;

50         case MOSCircuitAttributes.END2_IFINDEX:
           setIfIndex(ENDPOINT2, i);
           break;

55         case MOSCircuitAttributes.END3_IFINDEX:
           setIfIndex(ENDPOINT3, i);
           break;

55         case MOSCircuitAttributes.END1_VPI:
           setVpi(ENDPOINT1, i);
           break;

60         case MOSCircuitAttributes.END2_VPI:
           setVpi(ENDPOINT2, i);
           break;

65         case MOSCircuitAttributes.END3_VPI:
           setVpi(ENDPOINT3, i);
           break;
      }
    }
  }
}

```

```

case MOSCircuitAttributes.END1_VCI:
    setVci(ENDPOINT1, i);
    break;

5      case MOSCircuitAttributes.END2_VCI:
        setVci(ENDPOINT2, i);
        break;

10     case MOSCircuitAttributes.END3_VCI:
        setVci(ENDPOINT3, i);
        break;

15     case MOSCircuitAttributes.END1_DLCL:
        setDlcI(ENDPOINT1, i);
        break;

20     case MOSCircuitAttributes.END2_DLCL:
        setDlcI(ENDPOINT2, i);
        break;

25     case MOSCircuitAttributes.END3_DLCL:
        setDlcI(ENDPOINT3, i);
        break;

30     case MOSCircuitAttributes.END1_CATEGORY_TYPE:
        setEndpointType(ENDPOINT1, i);
        break;

35     case MOSCircuitAttributes.END2_CATEGORY_TYPE:
        setEndpointType(ENDPOINT2, i);
        break;

40     case MOSCircuitAttributes.END3_CATEGORY_TYPE:
        setEndpointType(ENDPOINT3, i);
        break;

45     case MOSCircuitAttributes.END1_SWITCH_IPADDR:
        setIPAddress(ENDPOINT1, i);
        break;

50     case MOSCircuitAttributes.END2_SWITCH_IPADDR:
        setIPAddress(ENDPOINT2, i);
        break;

55     case MOSCircuitAttributes.END3_SWITCH_IPADDR:
        setIPAddress(ENDPOINT3, i);
        break;

60     case MOSCircuitAttributes.END1_SLOT:
        setSlot(ENDPOINT1, i);
        break;

65     case MOSCircuitAttributes.END2_SLOT:
        setSlot(ENDPOINT2, i);
        break;

65     case MOSCircuitAttributes.END3_SLOT:
        setSlot(ENDPOINT3, i);
        break;

60     case MOSCircuitAttributes.END1_PPORT:
        setPPort(ENDPOINT1, i);
        break;

65     case MOSCircuitAttributes.END2_PPORT:
        setPPort(ENDPOINT2, i);
        break;

```

```

case MOSCircuitAttributes.END3_PPOT:
    setPPort(ENDPOINT3, i);
    break;
5
case MOSCircuitAttributes.END1_CHANNEL:
    setChannel(ENDPOINT1, i);
    break;
10
case MOSCircuitAttributes.END2_CHANNEL:
    setChannel(ENDPOINT2, i);
    break;
15
case MOSCircuitAttributes.END3_CHANNEL:
    setChannel(ENDPOINT3, i);
    break;
case MOSCircuitAttributes.END1_LPORT_TYPE:
    setLPortType(ENDPOINT1, i);
    break;
20
case MOSCircuitAttributes.END2_LPORT_TYPE:
    setLPortType(ENDPOINT2, i);
    break;
25
case MOSCircuitAttributes.END3_LPORT_TYPE:
    setLPortType(ENDPOINT3, i);
    break;
case MOSCircuitAttributes.END1_CARD_TYPE:
    setCardType(ENDPOINT1, i);
    break;
30
case MOSCircuitAttributes.END2_CARD_TYPE:
    setCardType(ENDPOINT2, i);
    break;
35
case MOSCircuitAttributes.END3_CARD_TYPE:
    setCardType(ENDPOINT3, i);
    break;
40
case MOSCircuitAttributes.END1_SWITCH_TYPE:
    setSwitchType(ENDPOINT1, i);
    break;
45
case MOSCircuitAttributes.END2_SWITCH_TYPE:
    setSwitchType(ENDPOINT2, i);
    break;
50
case MOSCircuitAttributes.END3_SWITCH_TYPE:
    setSwitchType(ENDPOINT3, i);
    break;
55
case MOSCircuitAttributes.END1_SWITCH_REVISION_NO:
    setSwitchRevisionNumber(ENDPOINT1, i);
    break;
60
case MOSCircuitAttributes.END2_SWITCH_REVISION_NO:
    setSwitchRevisionNumber(ENDPOINT2, i);
    break;
65
case MOSCircuitAttributes.END3_SWITCH_REVISION_NO:
    setSwitchRevisionNumber(ENDPOINT3, i);
    break;
case MOSFilterAttributes.MOS_INTERVAL:
    setInterval(i);

```

```

        break;

    case MOSFilterAttributes.MOS_START_TIME:
        setStartTime(i);
        break;
5
    case MOSFilterAttributes.MOS_STOP_TIME:
        setStopTime(i);
        break;
10
    default:
        break;
    }
}
15
}
...
}
20
LPortEthernetIfc

public interface LPortEthernetIfc
    extends LPortGenericEntityIfc
25
{
    public abstract String getLPortName();

    public abstract int getLPortType();

30    public abstract int getServiceType();

    public abstract int getIntefaceNumber();

    public abstract String getIPAddress();

35    public abstract String getNetworkId();

    public abstract Vector getAllCategoriesForLPort();

    public abstract String getDisplayStringForCategory(int category);

    public abstract Hashtable getAttributesForCategory(int category);

40    public abstract MOSIntervalCache getIntervalCache();

    public abstract MOSIntervalCache getIntervalCache();

45
}

LPortEthernetImpl

50    public class LPortEthernetImpl extends LPortGenericEntityImplAbs
        implements LPortGenericEntityIfc
    {
        public LPortEthernetImpl()
        {
55
        }

        /*-----*/
        /** Initialize the LPort object.
         * This method is used on the server side.
         */
        ** @param BFWServerRequest request
        ** @return void
        */
60        public void initialize(BFWServerRequest request)
            throws BFWExceptionAbs, NXException
65        {
            /*
             * Set the LPort attribute cache size
            */
        }
    }
}

```

```

super.initialize(DEF_LPORT_CACHE_SIZE);
this.request = request;
objectID = request.getObject().getObjectId();
argList = request.getObject().getAttrList();
handle = request.getObject().getObjectId().getComponent("NAME").toString();

5   switch(request.getType())
{
    case NXCommands.GET_STATS_CMD:
    case NXCommands.GET_DEMAND_STATS_CMD:
        case NXCommands.GET_PERIODIC_STATS_CMD:
        case NXCommands.START_MONITOR_CMD:
            // All attributes of LPort Type and Service Type
            // need to be initialized
10    setFilterAttributes();
    setObjectType();
        break;
    case NXCommands.GET_CMD:
        case NXCommands.GET_OPER_INFO_CMD:
15    setFilterAttributes();
    setSpecificAttrs();
        break;
    case NXCommands.STOP_STATS_CMD:
        case NXCommands.STOP_MONITOR_CMD:
20    setFilterAttributes();
        break;
    default:
        break;
25    }
}

30 }

/*-----*/
/* Initialize the LPort object with the NXObject
** This method is used on the client side.
** @param NXObject obj
** @return void
*/
35 public void initialize(NXObject obj)
throws BFWExceptionAbs, NXException
40 {
    // Set the LPort attribute cache size
    super.initialize(DEF_LPORT_CACHE_SIZE);
    // List of objects that are returned from the server
    clientObjectList = new Vector();
45    object = obj;
    argList = obj.getAttrList();
    handle = obj.getObjectId().getComponent("NAME").toString();
    setFilterAttributes();
    setObjectType();
50    }

/*-----*/
/* Initialize the LPort object with the attribute list
** This method is used to initialize the object from the
** cache manager
** @return void
*/
55 public void initialize()
throws BFWExceptionAbs, NXException
60 {
    // Set the LPort attribute cache size
    super.initialize(DEF_LPORT_CACHE_SIZE);
}

65 public Enumeration getAllAttributes()
{
    return getAttributeEntries();
}

```

```

    }

    public void setFilterAttributes()
    {
        NXArg arg = null;
        int i = 0;

        if (argList == null)
            return;
        for (int x = 0; x<argList.length(); x++)
        {
            arg = argList.getArgAt(x);
            i = arg.getId();
            switch(i)
            {
                case NXLPortAttributes.SERVICE_TYPE:
                    setServiceType(i);
                    break;

                case NXLPortAttributes.NAME:
                    setLPortName(i);
                    break;

                case NXLPortAttributes.TYPE:
                    setLPortType(i);
                    break;

                case NXLPortAttributes.IF_INDEX:
                    setInterfaceNumber(i);
                    break;

                case NXSwitchAttributes.IP_ADDRESS:
                    setIPAddress(i);
                    setNetworkId(i);
                    break;

                case MOSFilterAttributes.MOS_INTERVAL:
                    setInterval(i);
                    break;

                case MOSFilterAttributes.MOS_START_TIME:
                    setStartTime(i);
                    break;

                case MOSFilterAttributes.MOS_STOP_TIME:
                    setStopTime(i);
                    break;

                default:
                    break;
            }
        }
        ...
    }
}

```

60

Code Samples of Action Objects:**BFWAddActionIfc**

```

public interface BFWAddActionIfc
    extends BFWActionIfc
{
    /*-----*/
    /** Initialize the add action
     * @param BFWServerAddRequest addRequest
     * @return void
     * @exception BFWExceptionAbs */
    /*-----*/
10   public abstract void initialize(BFWServerAddRequest addRequest)
        throws BFWExceptionAbs, NXException,
}

15 BFWAddActionImpl

public class BFWAddActionImpl extends BFWActionImplAbs
    implements BFWAddActionIfc
{
    /*-----*/
    /** Set the target object to perform the action on
     * @param BFWNetworkEntityImpl actionTarget
     * @return void
     * @exception BFWExceptionAbs */
    /*-----*/
20   public void setTarget(BFWNetworkEntityImpl actionTarget)
        throws BFWExceptionAbs
    {
        if(actionTarget != null)
            if(actionTarget instanceof BFWNetworkEntityImpl)
                target = actionTarget;
    }

    /*-----*/
30   /** Get the target object to perform the action on
     * @return BFWNetworkEntityImpl */
    /*-----*/
35   public BFWNetworkEntityImpl getTarget()
    {
        return target;
    }

    /*-----*/
40   /** Do the verification on the object before performing the action
     * @return void
     * @exception BFWExceptionAbs
     * @exception NXException */
    /*-----*/
45   protected void handleVerification()
        throws BFWExceptionAbs, NXException
    {

        try
        {
50           verificationMethod = target.getObjectImplClass().getDeclaredMethod("addVerification", null);
           verificationMethod.invoke(null, null);
        }
        catch (InvocationTargetException e)
        {
55           BFWResponseManager.sendResponse(request, (NXException)e.getTargetException());
        }
        catch (Exception ex)
        {
60           BFWResponseManager.sendResponse(request, (NXException)ex);
        }
65     }
}

```

BFWDeleteActionImpl

```

5      /*-----*/
6      /** Perform the synchronous add action.
7       *  @return void
8       *  @exception BFWExceptionAbs
9       *  @exception NXException
10      /*-----*/
11      protected void handleDo()
12          throws BFWExceptionAbs, NXException
13      {
14
15          try
16          {
17              NXError error =
18                  BFWDataAccessManager.getInstance().addObject(target, request);
19              if (error.getErrorCode() != NXCommonErrors.NO_ERROR)
20              {
21                  throw new NXException(error.getErrorCode());
22              }
23              else
24              {
25                  BFWResponseManager.sendResponse(request, error);
26              }
27          }
28          catch (NXException e)
29          {
30              throw e;
31          }
32
33      /*-----*/
34      /** Initialize all attributes for the add action
35       *  @param BFWServerAddRequest addRequest
36       *  @return void
37       *  @exception BFWExceptionAbs
38       *  @exception NXException
39       */
40      public void initialize(BFWServerAddRequest addRequest)
41          throws BFWExceptionAbs, NXException
42      {
43          request = addRequest;
44
45          BFWNetworkEntityImpl target = null;
46          protected BFWServerAddRequest request = null;
47          private static Method verificationMethod;
48      }

```

BFWDeleteActionIfc

```

50     public interface BFWDeleteActionIfc
51         extends BFWActionIfc
52     {
53
54         /*-----*/
55         /** Initialize the delete action
56          *  @param BFWServerDeleteRequest deleteRequest
57          *  @return void
58          *  @exception BFWExceptionAbs
59          */
60         public abstract void initialize(BFWServerDeleteRequest deleteRequest)
61             throws BFWExceptionAbs, NXException;
62     }

```

BFWDeleteActionImpl

```

65     public class BFWDeleteActionImpl extends BFWActionImplAbs

```

```

    implements BFWDeleteActionIfc
{
    /*-----*/
    /** Set the target object to perform the action on
     *  @param BFWNetworkEntityImpl actionTarget
     *  @return void
     *  @exception BFWExceptionAbs
     */
    public void setTarget(BFWNetworkEntityImpl actionTarget)
        throws BFWExceptionAbs
    {
        if(actionTarget != null)
            if(actionTarget instanceof BFWNetworkEntityImpl)
                target = actionTarget;
    }

    /*-----*/
    /** Get the target object to perform the action on
     *  @return BFWNetworkEntityImpl
     */
    public BFWNetworkEntityImpl getTarget()
    {
        return target;
    }

    /*-----*/
    /** Do the verification on the object before performing the action
     *  @return void
     *  @exception BFWExceptionAbs
     *  @exception NXException
     */
    protected void handleVerification()
        throws BFWExceptionAbs, NXException
    {
        try
        {
            verificationMethod = target.getObjectImplClass().getDeclaredMethod("deleteVerification", null);
            verificationMethod.invoke(null, null);
        }
        catch (InvocationTargetException e)
        {
            BFWResponseManager.sendResponse(request, (NXException)e.getTargetException());
        }
        catch (Exception ex)
        {
        }
    }

    /*-----*/
    /** Perform the synchronous delete action.
     *  @return void
     *  @exception BFWExceptionAbs
     *  @exception NXException
     */
    protected void handleDo()
        throws BFWExceptionAbs, NXException
    {
        try
        {
            NXError error =
                BFWDataAccessManager.getInstance().deleteObject(
                    target, request);

            if (error.getErrorCode() != NXCommonErrors.NO_ERROR)
                throw new NXException(error.getErrorCode());
            else
                BFWResponseManager.sendResponse(request, error);
        }
    }
}

```

```

        }
        catch (NXException e)
        {
            throw e;
5       }

/*
10  ** Initialize all attributes for the delete action
    ** @param BFWServerDeleteRequest deleteRequest
    ** @return void
    ** @exception BFWExceptionAbs
    ** @exception NXException
*/
15 public void initialize(BFWServerDeleteRequest deleteRequest)
    throws BFWExceptionAbs, NXException
{
    request = deleteRequest;
}
20 BFWNetworkEntityImpl target = null;
protected BFWServerDeleteRequest request = null;
private static Method verificationMethod;
25
}

```